

# Livestock-Fishery Interaction Studies

**BIG CREEK** 

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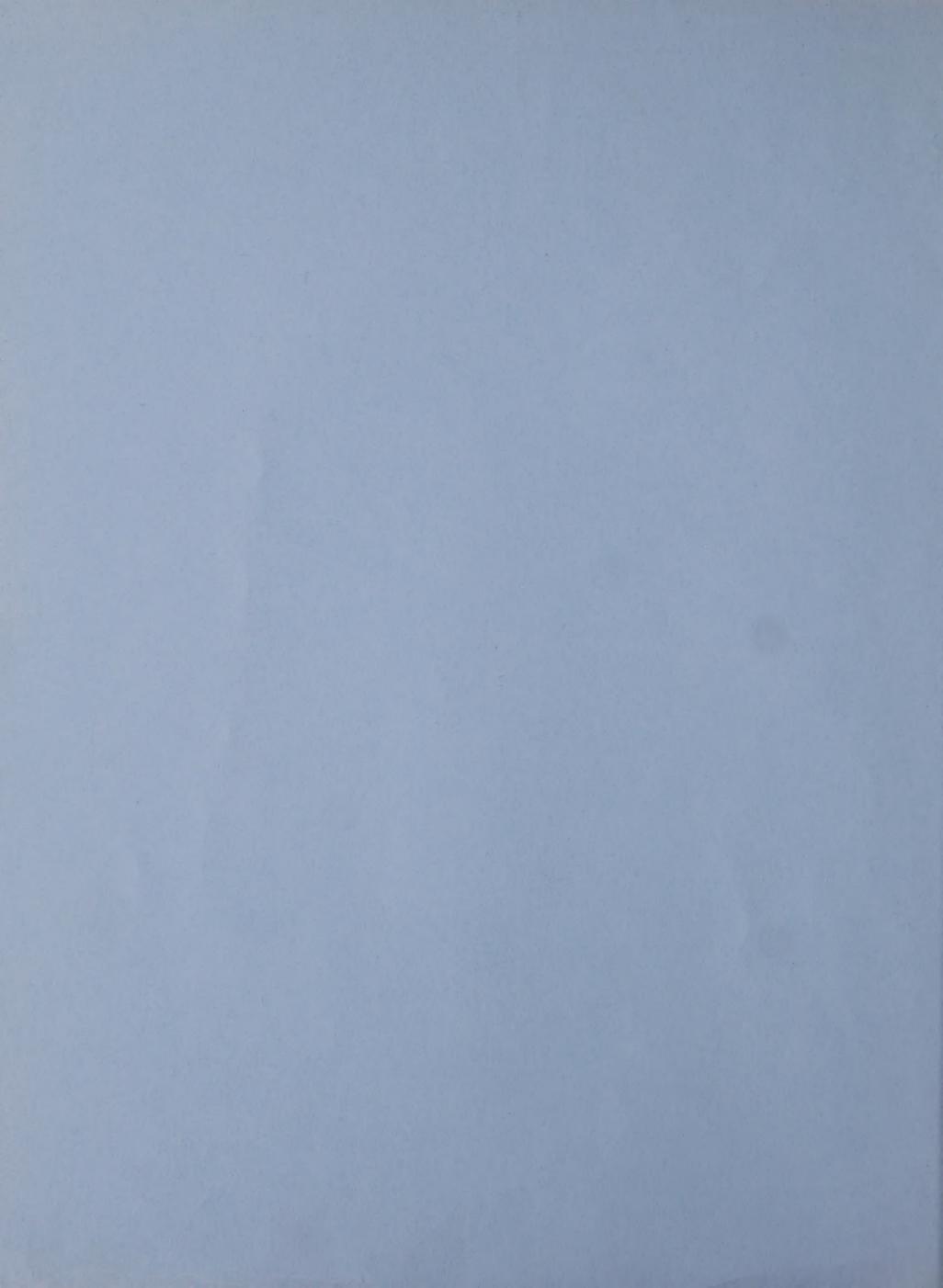
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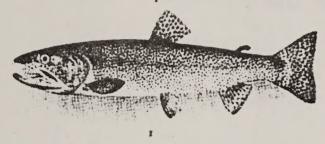


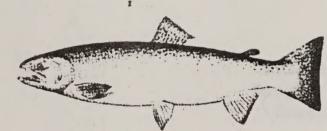




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# LIVESTOCK-FISHERY INTERACTION STUDIES BIG CREEK, UTAH

Progress Report 1 to the USDI, Bureau of Land Management
Salt Lake City, Utah

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#### PREFACE AND ACKNOWLEDGEMENTS

This progress report represents the study and integration of informative material from various sources and presents the results of the 1979 cooperative livestock grazing and fisheries habitat study of Big Creek, Rich County, Utah. Except as otherwise noted, however, all facts and figures pertaining to the Randolph Planning Unit and the Big Creek Allotment were obtained from the Randolph Planning Unit Grazing Management Environmental Statement prepared by the U. S. Department of the Interior, Bureau of Land Management, Salt Lake District, Salt Lake City, Utah; as a result this document is seldom referenced in the text. Special appreciation is extended to Cal McClusky, Salt Lake District BLM for information and photographs; to Dave Young, Fisheries Biologist, Sevier River Resource Area, Richfield District BLM for photographs depicting field methodology; to the Utah Division of Wildlife Resources (DWR) and the Northern Region fisheries workers involved for their cooperation in fish population sampling; to Dave Barnholdt, Fisheries Biologist, Salt Lake District BLM; and Don Duff, Fisheries Biologist, Utah State Office BLM for their efforts in overall study coordination. Fishery study field data collection and analysis is the product of work performed by the authors.

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#### INTRODUCTION

There are 1.9 billion acres of land in the 48 conterminous United States, of which some 1.2 billion (63 percent) are rangelands; as of 1970, 69 percent of this range was grazed by domestic livestock. In the western United States, most of these rangelands are public lands administered by federal agencies. In Utah, for example, 66 percent of the state is federally owned and of this, some 24 million acres (43 percent) is administered by the USDI, Bureau of Land Management (BLM).

Many streams of various sizes traverse this vast area, but despite their prevalence (Utah, for example, has some 2500 miles of stream on BLM land) they represent relatively little acreage. These streams, together with their adjacent riparian zones, contribute significantly to the productivity of the range, especially in arid and semi-arid regions, and present unique problems in multiple-use management. Unfortunately, this fact has only recently become widely appreciated and streams and riparian zones have frequently been ignored in rangeland planning and management in the past, largely due to their small relative size.

The various classes of livestock utilize the range in different ways, necessitating different management practices to increase the compatibility of each class with riparian and aquatic habitat. Cattle, for example, will congregate on lesser slopes and bottomlands, while sheep, which are less dependent on water, usually favor steeper slopes and upland areas (Stoddart and Smith 1955). Since sheep are also usually herded and cattle are not, management techniques to keep watersheds from being significantly altered differ between these two classes of livestock. The commonly used cattle management techniques are suspected to be less congenial than those used with sheep and are therefore the focus of this study.

Since the riparian zone, which forms the interface between the aquatic and the dryer terrestrial range ecosystems, is disproportionately important to both areas, application of effective management to this ecosystem is critical. Because of soil moisture, soil fertility, and related factors, the riparian ecosystem is more productive than the drier upland range, and its vegetation is more palatable. Coupled with this are other riparian features, such as gentler terrain, increased shade, and drinking water, which add to the attractiveness of this zone to cattle and lead to preferential use.

<sup>1/</sup>Duff, D. 1980. Personal correspondence. USDI, BLM, Utah State Office, Salt Lake City, Utah.

The riparian zone also provides critical fishery habitat components which are largely determined by streamside vegetation. Overhanging vegetation and undercut streambanks are an important source of protective cover, food, and shade. Shading prevents water temperatures from rising or fluctuating drastically, which can lead to shifts in species composition from salmonids to more tolerant species of non-game fish (Platts 1980). In addition, detritus formed from terrestrial plants is a principal source of food for aquatic invertebrates and ultimately fish (Minshall 1967). Streamside vegetation also serves as a barrier to terrestrial pollutants and controls water velocity and streambank erosion. Since these features are all susceptible to alteration by grazing animals, the needs of the resident fishery and the stockman can conflict.

Presently, there is an unfortunate dearth of factual information regarding the impacts of livestock grazing on riparian and aquatic ecosystems. As yet, only limited research has been directed toward lessening these impacts, though the constant increase in range use by cattle since the late 1800's has generally degraded rangelands and led to altered riparian habitat (Platts 1978). The resulting controversy surrounding the use of public rangelands by livestock and its potential conflicts with fishery needs has led to the emergence of livestock management as a national environmental issue (Leopold 1975; Platts 1978).

Working in this information vacuum, fisheries biologists have intuitively hypothesized that grazing of the riparian zone can significantly alter a fishery. Such alteration is believed to occur through physical modification of key stream features. Such changes as channel broadening, decreases in depth and pool-riffle ratio, loss of vegetative and structural cover, accelerated bank erosion and sedimentation, increased water temperature, and related factors are expected to modify the character of the fishery. These changes, however, have yet to be sufficently evaluated and identified for routine inclusion in management strategies. Additional studies that will provide solutions to these potential problems must be conducted (Meehan and Platts 1978).

Against this background of limited information, it should come as no surprise that little help can be given the land manager in determining alternate strategies in situations where livestock are known to be exerting undue stress on the fishery. Valid analytical techniques for assessing the magnitude of livestock impacts have yet to be fully developed. Without these tools, it is difficult to determine whether changes in grazing patterns are indicated and what strategies should be implemented.

The Big Creek study is part of a comprehensive program to develop an array of field techniques coupled with computerized analysis that will accurately identify the complex interactions that occur between different grazing intensities and classes of livestock and fish. Field studies are currently being conducted on eleven sites in Idaho, two sites in Nevada, and two sites in Utah (Figure 1). The Idaho studies monitor impacts to streams in moist, forested, high mountain meadows, while the Utah and Nevada studies monitor impacts to streams in the more arid sagebrush type meadows. These studies are structured to allow time-trend analysis of livestock impacts on streams and will help the land manager select grazing systems that are as compatable as possible with fishery needs.

# SALMON RIVER DRAINAGE

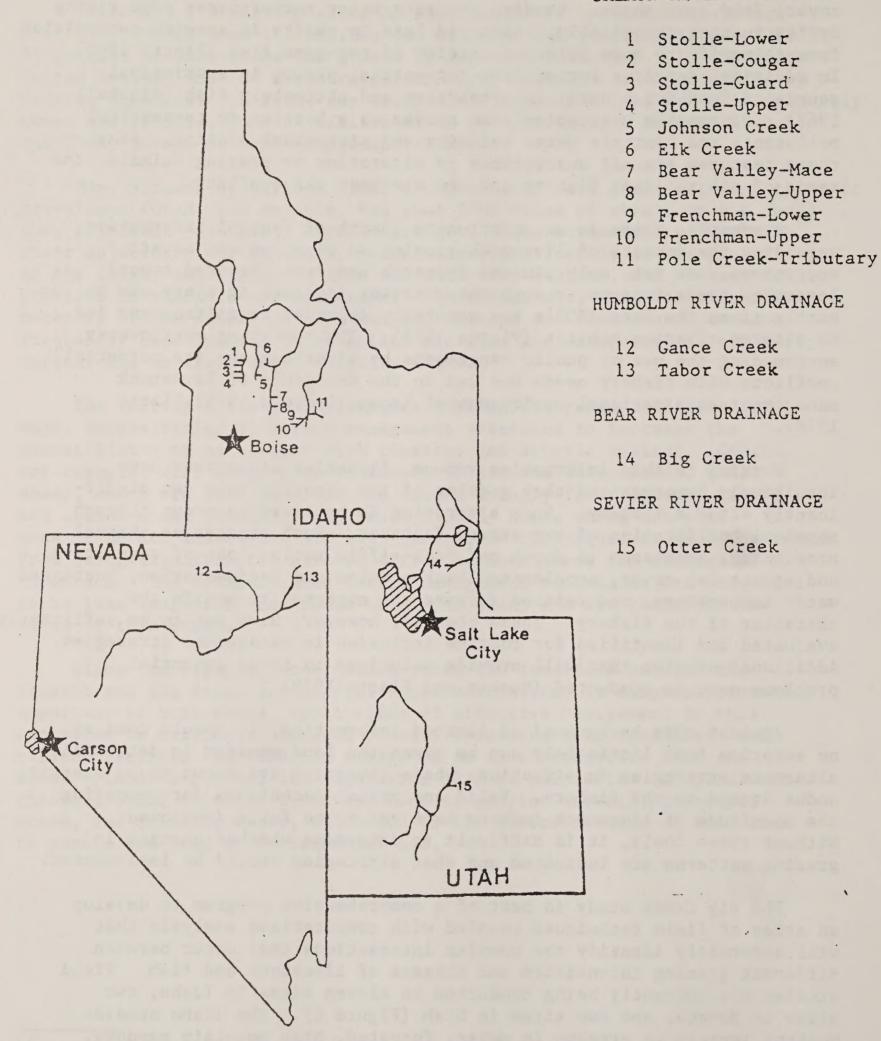


Figure 1. Distribution of livestock-fishery study sites

This progress report deals exclusively with the Big Creek, Utah study which has the following objectives:

- 1. Determine the rehabilitation potential of Big Creek based on past, present, and future use strategies.
- 2. Evaluate the improved management techniques proposed by the BLM.
- 3. Evaluate the continuous grazing system currently in use on the Big Creek Allotment.
- 4. Make recommendations regarding optimum grazing strategies relative to use of riparian forage.

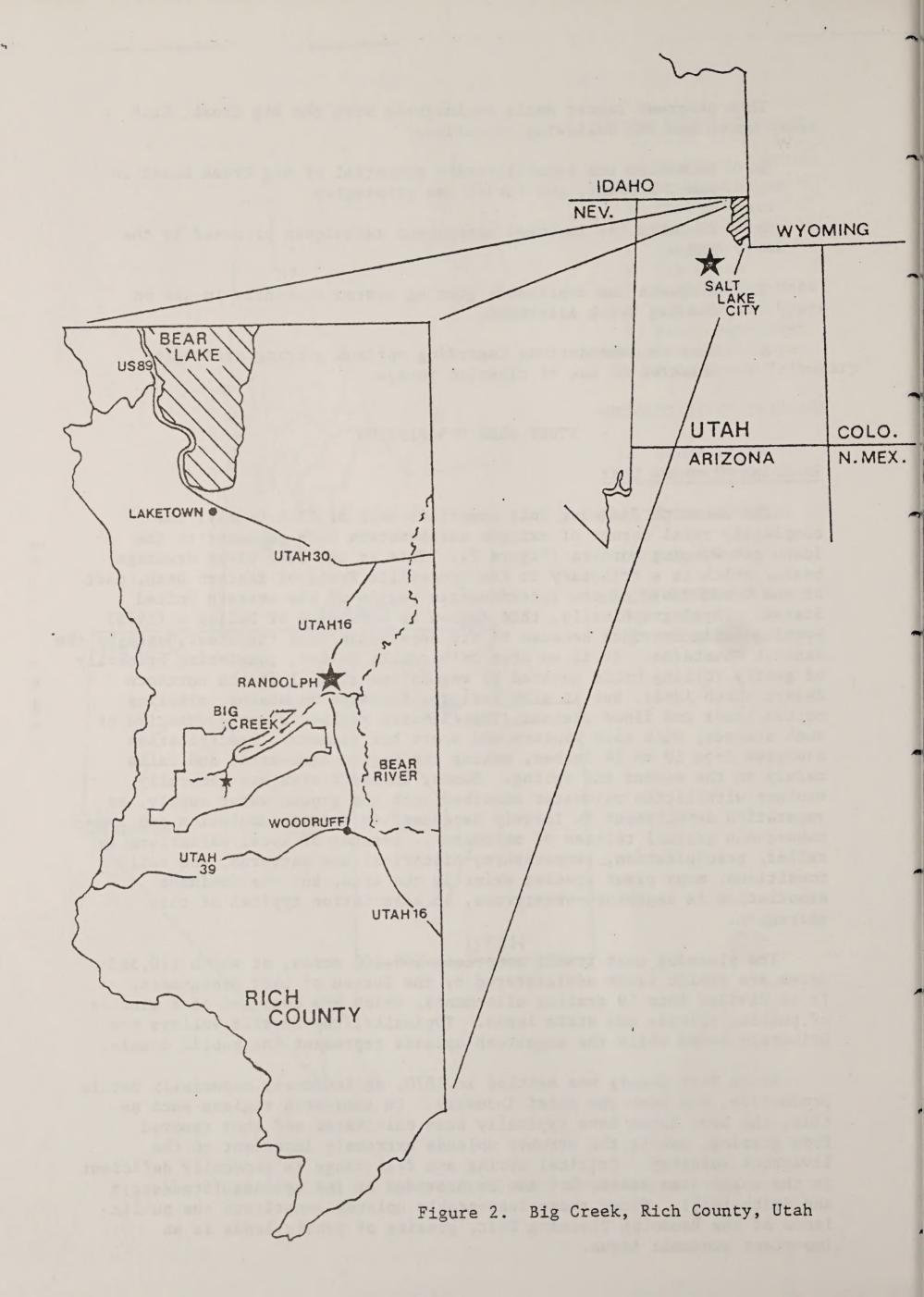
#### STUDY AREA DESCRIPTION

# Randolph Planning Unit

The Randolph Planning Unit comprises much of Rich County, the completely rural corner of extreme northeastern Utah adjacent to the Idaho and Wyoming borders (Figure 2). This is the Bear River drainage basin, which is a tributary to the Bonneville Basin of Eastern Utah, part of the Great Basin of the Intermountain region of the western United States. Physiographically, this region is also part of Bailey's (1978) Wyoming Basin Province because of its separation from the Great Basin by the Wasatch Mountains. It is an area of variable relief, consisting primarily of gently rolling hills covered by vegetation typical of the northern desert shrub lands, but it also includes forested mountains, alkaline bottom lands and flood plains. The climatic regime is representative of such steppes, with cold winters and short hot summers. Precipitation averages from 10 to 14 inches, making the region semi-arid, and falls mainly in the winter and spring. Summer thunderstorms are generally violent with little rainwater absorbed into the ground water supply, so vegetation development is largely dependent on snow accumulation and subsequent gradual release of meltwater. Because of local variations in relief, precipitation, temperature, historical use patterns, and soil conditions, many plant species exist in the area, but the dominant association is sagebrush-wheatgrass, an association typical of this ecoregion.

The planning unit itself comprises 569,102 acres, of which 170,583 acres are public lands administered by the Bureau of Land Management. It is divided into 19 grazing allotments, which are composed of a mixture of public, private and state lands. Typically, the fertile valleys are privately owned while the sagebrush uplands represent the public domain.

Since Rich County was settled in 1870, agriculture, especially cattle production, has been the chief industry. In semi-arid regions such as this, the best lands have typically been cultivated and thus removed from grazing, making the shrubby uplands extremely important to the livestock industry. Critical spring and fall range is generally deficient in the cultivated areas, but can be provided by the uplands (Stoddart and Smith 1955). Since these less-arable uplands constitute the public lands of the Randolph Planning Unit, grazing of public lands is an important economic issue.



# Big Creek Allotment

Big Creek is the third largest of the 19 grazing allotments in the Randolph Planning Unit, and is located immediately southeast of the city of Randolph (Figure 2). Its 20,346 acres include two perennial streams, Randolph Creek and Big Creek. The latter is currently being studied by the Bureau of Land Management to assess livestock impacts on riparian and aquatic habitat. Part of the allotment has been fenced to exclude cattle from 0.6 miles of stream, so that time trends in stream deterioriation or repair can be monitored. This exclosure currently represents the only stream reach in the planning unit rated by the Bureau to be good fishery habitat (Photographs 1 and 2).

#### THE SITUATION

# Range Habitat

The land surrounding Big Creek is a semi-arid shrubsteppe. As is generally the case in ecosystems controlled by abiotic factors, the plant and animal communities are dominated by a few very abundant species. In this instance, the rolling hills support an almost uniform growth of big sagebrush (Artemesia tridentata); a plant of relatively little forage value for livestock. This vegetation type, of which 75% is this one species, accounts for 65% of the BLM land in the planning unit. Surprisingly, in light of this abundance big sagebrush may not even be the natural dominant in many cases. The second most abundant vegetation type in the planning unit as a whole is bunchgrass, represented chiefly by the exotic, palatable, crested wheatgrass (Agropyron cristatum), which accounts for only 9.1% of the vegetation.

Sagebrush, though undoubtedly an important component of the natural climax vegetation, may not naturally be the dominant it now is. Considerable evidence exists which points to grazing-induced vegetation shifts being the cause of its present dominance over much of the western range (Bailey 1978; Christensen and Johnson 1964; Christensen 1963; Stoddart and Smith 1955; USDA 1936). Christensen (1963), in fact, reporting on undisturbed stands of grasses dominated by bluebunch wheatgrass in central Utah, states that in areas protected from grazing, sagebrush is rarely dominant. From such evidence, it seems likely that in northeastern Utah, which is subject to considerable influence from the Great Plains to the east, much of the land now dominated by sagebrush would be climax grassland in the absence of grazing.

Normal plant succession progresses toward a climax type that is most stable relative to ambient conditions. Disruptive forces or long term changes in ambient conditions can modify this sequence, however, favoring another species composition. In the intermountain region, cattle may represent a long term change in ambient conditions, selectively exerting grazing pressure on the bunchgrasses relative to the sagebrush. Coupled with a history of range overuse, a shift in species composition toward big sagebrush dominance is to be expected. Thus, the quality of the range deteriorates in response to grazing pressure, possibly maintaining big sagebrush as a grazing disclimax.



Photograph 1. Stream reach in central portion of the existing Big Creek exclosure. Note abundant grasses on streambanks and dense sagebrush beyond fenceline.



Photograph 2. Stream reach in upper section of the exclosure. Note overhanging grasses as well as the willow on the right bank.

In order to control this retrogressive succession, various management techniques are used. These include herbicide applications and burning to reduce brush cover, as well as various pasturing techniques to directly reduce grazing pressure at certain times.

# Riparian Habitat

In the Randolph Planning Unit, riparian vegetation accounts for only 0.7% of the BLM land. Because of this, it is easily and often overlooked in range planning. This highly productive zone that separates the aquatic ecosystem from the terrestrial range ecosystem is far more important than its low relative abundance would suggest. In fact, the Randolph Planning Unit Environmental Statement (USDI, BLM 1979) states that aquatic/riparian and fisheries habitat may be the most important type in Rich County. It's importance comes from the fact that crucial resources for wildlife, livestock, water quality and fish are provided by this zone. For livestock the riparian zone provides water, generally moister more palatable vegetation, gentle terrain and shade.

Since cattle may preferentially graze riparian vegetation, the riparian zone can be expected to be heavily used under any grazing system. If historical use patterns have led to general range deterioration, it is only reasonable to expect at least equal alteration of riparian habitat. Congregation of cattle along streambanks can modify the habitat through such direct physical action as reduction of streamside vegetation and bank trampling. These, in turn, can lead to decreases in overhanging cover, streambank stability, pool quality, pool-riffle ratio, and overall water quality. If shifts in riparian species composition parallel such shifts in upland range vegetation, selection for a grazing sub-climax in the riparian zone may also have occurred. This is important, because not all plants provide equal cover or bank stability.

#### Management Considerations

There are basically five systems of livestock management used to control the distribution of livestock over the range. These systems are continuous or seasonal grazing, rotation grazing, deferred grazing, deferred rotation grazing, and rest-rotation grazing (Meehan and Platts 1978). These commonly used systems are designed to increase range plant vigor, and thus help rangelands recover from historical abuse. Their effectiveness in promoting recovery of riparian vegetation, however, needs clarification.

Continuous grazing is common in the Randolph Planning Unit, and consists of stocking an allotment in the spring and removing the animals in the fall. It is almost a no-management system, except that timing of stocking and removal can be manipulated so as to avoid critical developmental stages of the forage plants. Nevertheless, it is an unsuccessful system, as noted by Hormay (1970) who states that under continuous grazing at any stocking level, the more palatable and accessible plants will be killed or eliminated.

Another popular grazing system is rest-rotation grazing, which subdivides an allotment into pastures which are then systematically grazed and rested. If correctly applied, this system can help restore the vigor of range plants, with the amount of rest required being determined by characteristics of the forage plants involved (Hormay 1970). Whether this system can benefit riparian vegetation, however, is still open to question. There are in fact indications that it cannot help the recovery of abused riparian habitat. Meehan and Platts (1978) suggest that this system may be harmful to riparian ecosystems because of increased potential/ for livestock movement and use of the riparian zone. A study by Starostkaon Seven-Mile Creek, Utah, suggests that not only may riparian habitats not be improved under a rest-rotation system, but increased production of riparian vegetation following a year of rest may increase the attractiveness of this zone to cattle. This could accelerate modification of the riparian zone since structural damage does not recover as rapidly as vegetation (photograph 3), nor do all plant species recover at the same rate. In an on-going BLM study, Duff (1978) found that woody vegetation along Big Creek recovered more slowly than grasses, and that only 6 weeks of grazing were required to return the riparian habitat within the Big Creek exclosure, which had been rested for four years, to pre-rest conditions.

The three other systems either defer grazing for parts of the season or are combinations of seasonal deferment and resting. None have clearly been shown to be effective in helping riparian vegetation recover though some may be more successful than others. Only one system clearly stands out as being useful in riparian recovery, and that is complete rest. This can be accomplished by fencing; as the BLM intends to do on some stream reaches in the Randolph Planning Unit, and though it cannot be the final solution it must be a consideration if high quality riparian habitat is to be conserved. The answer to this vexing problem should become clearer as this study progresses, as it will monitor three grazing systems; fencing in the exclosed area, the continuous system that has been historically used, and the rotationally deferred grazing and resting system to be implemented by the BLM to improve range conditions. This latter system will allow some rest during the season for the three pastures into which the Big Creek allotment will be sub-divided.

#### GRAZING PATTERNS

#### History

Since the settlement of Rich County in 1870, livestock production has remained the number one industry. This has primarily been represented by various sizes of cow-calf ranching operations, ranging from small operations averaging 65 head to large operations averaging 536 head. Because the allotments are used for spring to early winter grazing, the

<sup>2/</sup>Starostka, V. J. (n.d.) Some effects of rest-rotation grazing on the aquatic habitat of Seven-Mile Creek. Report on file USDA, Forest Service, Richfield, Utah.



Photograph 3. Stream reach in lower portion of the Big Creek exclosure. This section experienced some trespass use in 1979. Note the bank sloughing on the left bank. Note also the presence of grasses between sagebrush plants.

rancher must have sufficient winter forage for his cattle. For this reason, base property is used to determine the grazing preference which for the Big Creek Allotment is potentially 4045 AUM's (not including suspended non-use).

The present grazing preference of 4043 AUM's is the result of a 40% reduction in use over the three years 1961 through 1963. Subsequent to this reduction, readjudication sub-divided the Randolph Grazing Unit into the Big Creek and New Canyon Allotments. Of the 6742 AUM's potentially allocated for the Big Creek Allotment, 2697 were put into suspended non-use, leaving 4045 AUM's in active status. As can be seen from Table 1, however, the tendency has been for authorized use to be a lesser amount.

The historic management system for the Big Creek Allotment, and presumably the older Randolph Grazing Unit, has been an allotment-wide continuous system. This system normally provides no rest period for any part of the allotment during the grazing season, but in this case a drift fence built across the lower portion of the allotment defers grazing on the upper two-thirds of the allotment early in the season. Application of this system results in stocking the allotment in early May with no regard to development of the key forage species, and removal after attainment of permitted use. The level of use has been 3478 cattle AUM's reached in mid-September and 402 sheep AUM's reached in late-December. It should be noted that use intensity in AUM's is a function of animal numbers and time on the range; it gives no direct indication of vegetation use, which has consistently been heavy on the following scale:

Slight 0 - 10% Light 11 - 40% Moderate 41 - 60% Heavy 61 - 80% Severe 81 -100%

Such heavy use has, in turn, led to generally deteriorated range conditions, as evaluated by the 1978 range trend survey, which shows 61% of the range in static condition and 39% declining. Since 1978 was not a drought year and precipitation during the crop year was near normal, it is unlikely that this downward trend is a climatic artifact.

The Bureau of Land Management has determined that under present range conditions only 3116 AUM's forage are actually available to livestock, suggesting that the allotment has consistently been overstocked (Table 1) and necessitating a 25% reduction in stocking level. The range vegetation use was 65% for the years 1976, 1977, and 1978, 15% greater than the desired use of 50% for grasses and well into the heavy use level. Since riparian vegetation is frequently grazed more heavily

Anderson, G. (1979 unpublished). Big Creek allotment, grazing history and recommendations for MFP-3 decisions. (Unpublished data on file, USDI, BLM, Salt Lake Dist. Office, Salt Lake City, Utah).

rameter						YEAR					
1974		1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
20346		20346	20346	20346	20346	20346	20346	20346	20346	20346	20346
AWC1/		AWC	AWC	AWC	AWC	AWC	AWC	AWC	AWC	RDGR <sup>2</sup> /	RDGR
3478		3478	3478	3478	3478	3613	3225	2821	2618		
402	1	402	402	402	402	430	414	414	414		
3880	3	3880	3880	3880	3880	4043	3639	3235	3032		
5/10   5/	5/	5/10	5/10	5/10	5/10	5/10	5/16 <sup>5</sup> /	5/164/	5/16	5/16	5/16
9/15   9/	16	9/15	9/15	9/15	9/15	9/15	9/30	9/30	9/30	9/30	9/30
12/31 12	12	12/31	12/31	12/31	12/31	12/31	41/30	11/30	11/30	11/30	11/30
Heavy He (65%)	Не (6	Heavy (65%)	%59	%59	19%59	Moderate 7	24%	24%	54%	20%	20%
$\frac{10}{\text{Heavy}}$ S1		Slight	Slight	Slight	Slight	17.4%					
Heavy S	S	Slight	Slight	Slight	Slight	74.6%				-	
Allotment-wide continuous 3-pasture rotational deferred grazing and resting 5-year average 1974-1978 No partitioning information after 1982 Date dependent on permittees entering an Allotment Management Plan. If they don't, it may be moved to 5/25 and if they do, it could be as early as 5/10. (McCluskey pers. comm.)	s ed	grazin fter 19 enterin f, it m be as	deferred grazing and resting 978 mation after 1982 mittees entering an Allotmen they don't, it may be moved to it could be as early as 5/10 it.)	ting tment ed to 5/10.		6/ Anderson, un 7/ Moderate abo unpublished) 8/ Beginning 19 sites 1 and 9/ Estimated 19 10/ Heavy tressp 11/ Estimated 19	d d d d d	Tshed lrift data table 1978 use 1978	1	heavy below (Anderseleld study (average	(Anderson,

than the dryer range vegetation, the possibility exists that riparian vegetation has been utilized at the severe level. At the very least, this system can be expected to have led to a considerably altered riparian habitat.

In order to assess the damage to the riparian habitat and its ability to recover when removed from grazing pressure, the BLM constructed an exclosure on the Big Creek allotment to exclude 0.6 miles of the stream from grazing. Despite the occassional occurrence of trespass use, particularly in 1974 when aquatic and riparian conditions reverted to pre-rest conditions as a result of heavy use, the riparian and aquatic habitats have recovered markedly (Duff 1978). Trespass use again occurred in 1979, though apparently not quite as heavily. This small section of Big Creek presently accounts for all of the fishery habitat in Rich County that the BLM considers to be in good condition.

# Present and Future Trends

In order to improve overall range conditions on the allotment, the BLM has proposed a group of improved management techniques for future grazing use. As this is yet a proposal, implementation dates have not been determined. For the purposes of this report, 1980 will be used as the first season of implementation. Table 1 shows the trend in grazing management from 1974 through 1984 under this proposal.

As can clearly be discerned, the major initial changes for the Big Creek allotment will be a 25% reduction in total authorized use from 4043 AUM's to 3032 AUM's over a three year period (Table 1). This reduction will apparently be the result of an actual reduction in the number of cattle stocked, as the grazing season will be increased. The turn-on date will initially be set at 16 May, which will allow bluebunch wheatgrass (Agropyron spicatum) and crested wheatgrass (A. cristatum), two key forage species, to withstand grazing pressure. Thereafter, the turn-on date may be subject to adjustment depending upon the permittees; if they join an Allotment Management Plan (AMP) turn-on may occur as early as 10 May, if they do not join an AMP, turn-on will be set at 25 May (McCluskey—). Vegetation use (grass) will immediately be decreased to 54% with further reduction to 50% when the improved management is fully implemented.

Improved management will consist of a change in grazing system from an allotment-wide continuous system to a three-pasture rotational deferred grazing and resting system. Under this system, all three pastures will be grazed annually, but only one at any given time. Each pasture will therefore be rested for two-thirds of the season. With the combined use of herbicide and burning treatments and water developments, the BLM expects to increase forage production. Thus, the grazing intensity will be raised to 6494 AUM, more than double the present capacity. Concurrently, the alloted acreage may be reduced to 19966 acres due to disposal of some lands. This may require a reduction of the predicted 6494 AUM's, but the increase will still be substantial.

<sup>4/</sup>McCluskey, C. 1980. Personal correspondence, USDI, BLM, Salt Lake District Office, Salt Lake City, Utah.

As designed, the proposed improved grazing management may improve some of the aquatic and riparian habitat on the allotment, but little, if any, change is expected in aquatic/riparian and fishery habitat. The purpose of this improved management is to improve overall range conditions not fishery habitat in particular except on those stream reaches on which additional livestock exclosures will be constructed, which includes 2.9 miles on Randolph Creek in the allotment (USDI 1979).

#### **METHODS**

# General

Ongoing studies are presently being conducted on a total of 15 study sites, ll in Idaho and two each in Nevada and Utah. These sites are generally in meadow environments on National Forest lands, and lower elevation sagebrush type meadows on Bureau of Land Management lands. The purpose of these studies is to refine techniques for monitoring and assessing the impacts of livestock on riparian and aquatic ecosystems.

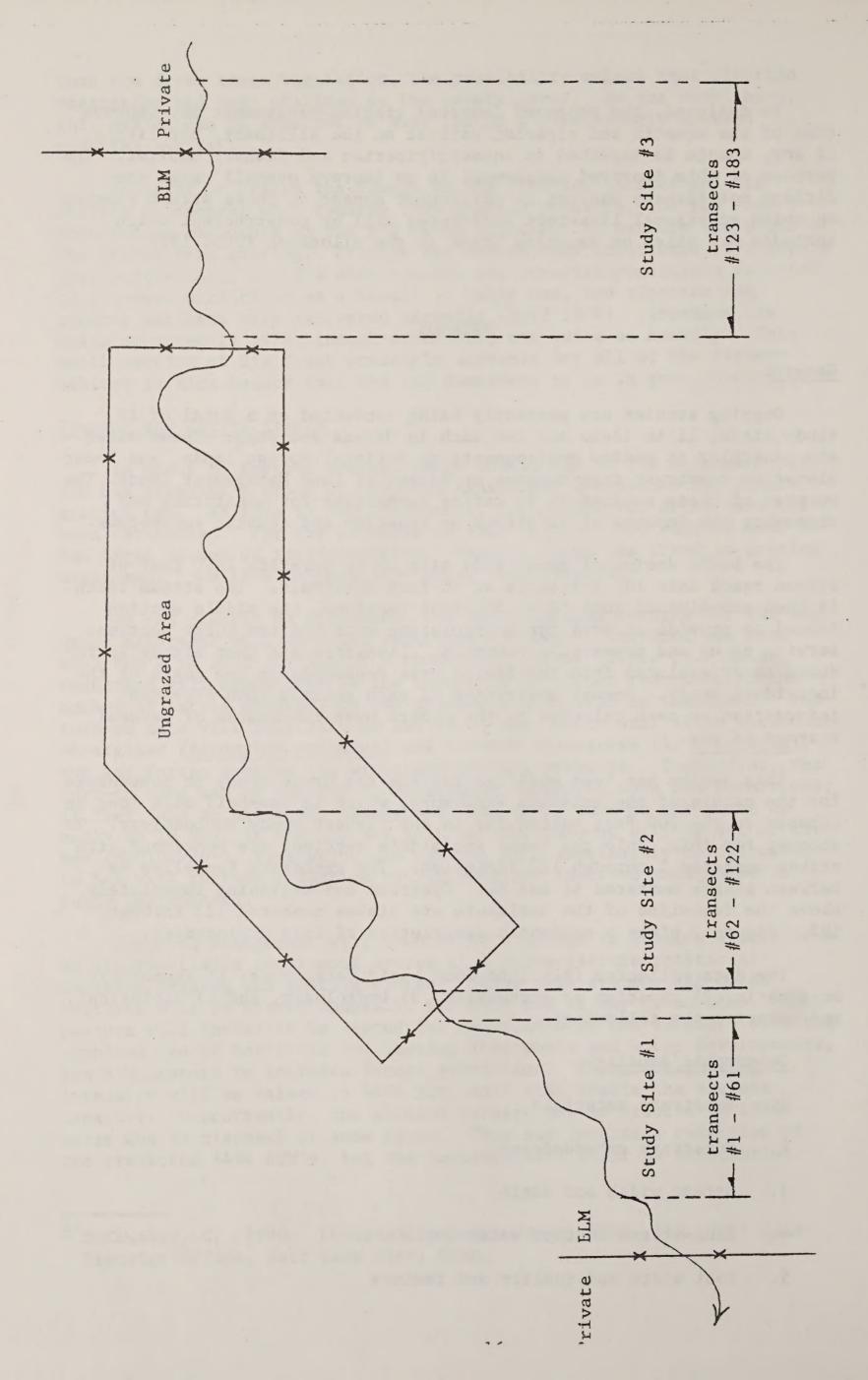
The basic design of each study site is to stratify 1810 feet of stream reach into 181 transects at 10-foot intervals. The stream reach is then sub-divided into three 600-foot sections, the middle section fenced to provide an area for manipulation with the two outer sections serving as up and downstream controls. Livestock are then either introduced to or excluded from the fenced area depending on the goals of the individual study. Annual monitoring of each section then provides information on each relative to the others over the course of several seasons of use.

This design has been modified for the Big Creek study to compensate for the nature of the existing exclosure, which is one-half mile long as opposed to the 600 feet called for in the fishery study methodology. To account for this, only the lower and middle sections are continous with stakes numbered 1 through 122 inclusive. The exclosure fenceline is between stakes numbered 61 and 62. Upstream and beginning immediately above the fenceline of the exclosure are stakes numbered 122 through 183. Figure 3 gives a schematic description of this arrangement.

The data collected fall into four basic categories: 1) geomorphic or aquatic, 2) riparian or streamside, 3) hydrologic, and 4) biological, and comprise the following:

#### Geomorphic/Aquatic

- 1. Substrate materials
- 2. Substrate embeddedness
- 3. Stream width and depth
- 4. Bank-stream contact water depth
- 5. Pool width and quality and feature



Schematic diagram of the Big Creek Livestock-Fishery Study area (not drawn to scale). Figure 3.

- 6. Riffle width
- 7. Streambank angle
- 8. Streambank undercut
- 9. Fisheries environment quality rating

# Riparian

- 10. Streamside habitat type
- 11. Streambank stability
- 12. Overhanging vegetation
- 13. Vegetation use (ocular and herbage meter)
- 14. Streambank alteration (natural and artificial)

# Hydrologic

- 15. Stream profile
- 16. Stream gradient
- 17. Stream velocity

# Biological

18. Fish species composition, number and biomass

A brief description of the procedures used in this study follows. More detailed descriptions can be found in Platts (1974), Platts (1976), Ray and Megahan (1978), Morris and others (1976), and Neal and others (1976).

# Geomorphic/Aquatic Analysis

These measurements describe the physiography of the stream being studied and can therefore be used to document livestock induced structural changes when monitored over several grazing seasons.

Substrate materials are classified into five classes by visually projecting each one-foot division of a measuring tape to the streambed surface and assigning the major observed sediment class to each division. Sediments are classified as boulder, rubble, gravel, and fine sediment.

Instream vegetative cover was a direct measurement of the vegetative cover on the channel intercepted by the transect. Stream channel substrate embeddedness measures the gasket effect of fine sediment around the larger size substrate particles.

Stream width is a horizontal measurement of that area of the transect covered by water. Stream depth is the average of four water depths taken at selected intervals across the transect from the water surface to the channel bottom. Water depth at the intersection of the streambank or stream channel with the edge of water is a direct measurement from water surface to channel bottom. Pools are classified as that area of the water column usually deeper than riffles and slower in water velocity. Riffle is the remainder of the column. Pool quality rating is based on the pool's ability to provide certain rearing requirements of fish, such as width, depth, and cover.

Streambank alteration readings attempt to quantify the natural and artificial changes occurring to the streambank, and are given as a percentage. The streambank angle is measured with a clinometer (photographs 4 and 5), which determines the downward slope of the streambank to the water. Streambank undercut is a direct horizontal measurement, parallel to the stream channel, of the erosion of the bank at the water influence area. Fisheries environment quality ratings depict the general ability of the bank-stream contact zone to provide the conditions believed necessary for high fish standing crops. This rating is a function of both stream characteristics at the bank (pool or riffle) and available cover.

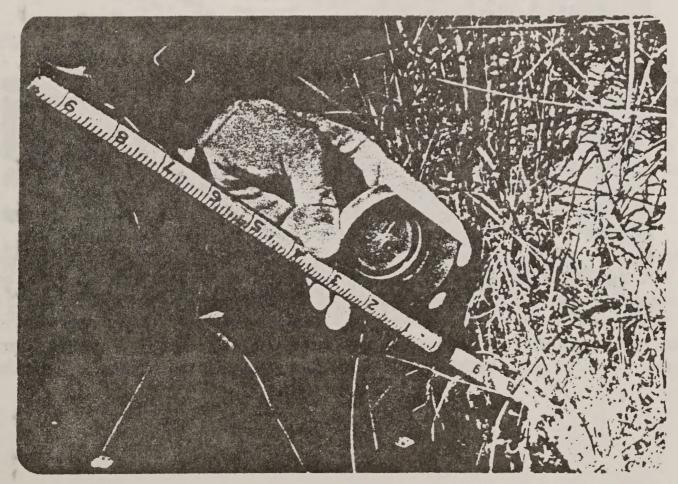
#### Riparian Analysis

These measurements attempt to describe the riparian interface between the aquatic and terrestrial ecosystems. This zone provides many of the habitat requirements of fish, such as cover and food. It is also especially vulnerable to degradation by livestock because such characteristics as higher forage production and palatability, shade, and even terrain tend to encourage preferential use. Annual monitoring of these data after the grazing season illustrates changes in many critical fishery habitat parameters.

Streamside cover categorized the dominant vegetation as tree, brush, grass, or exposed. Streamside cover stability was a four group rating of the ability of the streambanks to resist erosion. Vegetative overhang directly measures the length of the vegetation overhanging the water column within 12 inches of the water surface (Photographs 6 and 7). Habitat rating is based on the belief that sand banks are of least importance to fish, while brush-sod banks are of the greatest value. Intermediate types are ranked accordingly by dominant and subdominant characters. Measurement of vegetation use is done both by ocular assessment and with an herbage meter.



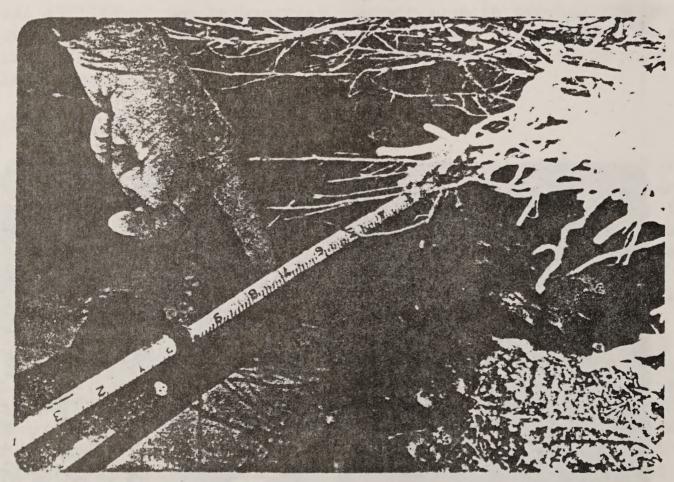
Photograph 4. Measurement of bank angle with an undercut bank angle of about 45°.



Photograph 5. Close up of clinometer showing measurement of bank angle with an undercut bank. Angle is about 45°.



Photograph 6. Measuring overhanging vegetation. Such overhang is an important source of fish cover.



Photograph 7. Measuring overhanging vegetation. Note that this shrub overhangs the stream about 1.5 feet.

# Herbage

In order to provide a quantitative complement to an ocular vegetation use assessment, a Neal Electronics model 18-2000 herbage meter is used to measure standing vegetation. These readings are taken at approximately every fourth transect, and linear regression analysis against clipped plots provides a quantitative measure of forage biomass and use.

# Electrofishing

Fish populations are sampled with either battery powered, portable, backpack mounted electrofishers or with gasoline powered, motor energized units. Salmonids are counted, measured, and weighed, while non-salmonids are counted and weighed as a group. All are handled as carefully as practicable, and promptly returned to the stream alive.

Big Creek was sampled with the cooperation and assistance of the Utah DWR using a backpack mounted Coffelt electrofisher set at 125 volts and 2.5 amperes. The stream was sampled in 600-foot sections.

# Hydraulic Geometry

Ten transects in the central section of each 600-foot stream reach are used for hydraulic geometry measurement. The data obtained here allow us to generate a stream cross section map. Periodic measurement over the course of the study shows quantitative changes due to erosion and deposition of channel materials. The stakes are surveyed to detect changes in their relative positions, and the water surface is surveyed to allow monitoring of changes in channel gradient.

#### RESULTS

# Geomorphic/Aquatic Analysis

The BLM livestock exclosure on Big Creek has been in place since 1970. The improved environmental condition of Big Creek in the exclosure is apparent in the data collected in 1979 (Table 2). The stream in the ungrazed area on Big Creek is narrower and deeper than the stream in the grazed sections. The fenced section of stream has a greater percentage of pool and less riffle than in the grazed areas. The stream banks are steeper (bank angle) and have more undercut in the ungrazed area.

The stream channel material composition is variable in the study area. It appears that fine sands comprise approximately 50% of the channel substrate materials in the ungrazed area. The high percentage of pool in that stream section probably results in more fine sands settling out of the water column. The fisheries rating was higher in the ungrazed area, indicating an environment better suited to fish than the grazed area.

Table 2. Geomorphic/aquatic and riparian means with their 95% confidence intervals for Big Creek, 1979 (8/9/79).

Variable	Mean	Site 1 Interval	Mean	Site 2 Interval	Mean	Site 3 Interval	Nean	Overall
GEOMORPHIC								
Stream width (ft)* Stream depth (ft)*	12.5	11.7 - 13.2 0.45- 0.59	11.7	10.9 - 12.4	12.9	12.1 - 13.6	12.3	11.9 - 12.8
Riffle (percent)* Pool (percent)*	78.5	71.8 - 85.2 14.8 - 28.2	42.9	36.0 - 49.6	61.7	55.0 - 68.4	61.2	57.2 - 64.9
Bank angle (deg)* Bank undercut (ft)*	136.2	129 -144 0 - 0.1	112.9	105 -120 0.15- 0.24	138.5	131 -146 0.02- 0.1	129.3	125 -134
Bank water depth (ft)* Embeddedness*	0.19	0.09- 0.3	0.59	0.5 - 0.7	0.61	0.5 - 0.7	0.47	0.4 - 0.5
Boulder (percent)*	0.1	0 - 0.3	0.4	0.3 - 0.6	0	0 - 0.1	0.2	0.1 - 0.3
Gravel (percent)* ·	81.3	74.9 - 87,7	24.1	16.6 - 29.5	50.9	44.6 - 57.2	8.6	6.1 - 11.0
Fines (percent)	15.4	N.A. 1/	51.3	N.A.	51.2	N.A.	39.3	× ×
Instream cover (ft) Fisheries rating*	1.2	0.3 - 2.0 $1.0 - 1.4$	3.3	2.4 - 4.1 2.4 - 2.8	5.1	4.3 - 5.9	3.2	2.7 - 3.7 $1.8 - 2.0$
RIPARIAN				Anys esign				
Bank cover stability* Habitat type*	1.7	1.6 - 1.9 $12.2 - 13.7$	3.4	3.2 - 3.6	2.0	1.8 - 2.2	2.4	1 1
Vegetation use (percent)* Alteration-natural (%)	76.1	73.1 - 79.0	17.4	14.4 - 20.4 $10.8 - 13.9$	73.1	70.1 - 76.1	55.8	54.1 - 57.5
Alteration overhang (fr)*	29.0	26.8 - 31.2	4.4	2.2 - 6.7	23.5	21.3 - 25.7	19.1	

1/N.A. - not available

\* Significant difference in site 2 mean relative to sites 1 and 3.

Results from analyzing the stream riparian environment (Table 2) also show the effects of non-use in the exclosure. Bank stability in the ungrazed area was rated almost two times higher than in the grazed sites. This suggests the streambanks are in good condition and able to withstand erosion. The habitat type rating for the ungrazed area showed that sod was the dominant component of the streamside, while that in the grazed area was grass. In this methodology, brush-sod banks are considered of greatest value to a fish environment.

Artificial alteration to the riparian environment rated much less in the ungrazed area than in the grazed sites. Vegetation use in the ungrazed area was slight at 17%, representing past use, while use in the grazed areas was 73-76%. The vegetation overhang supported this figure, with more vegetation shading the stream in the ungrazed site than the grazed sites. This vegetation could provide shade and cover for fish.

# Herbage Analysis

Regression analysis results for clipped plots on Big Creek are presented in Figure 4, derived herbage statistics in Table 3, and site specific comparisons in Table 4. Electronic capacitance herbage meters were used to measure vegetation in the study area for the first time in 1979, so no time trend analysis is possible yet.

The calibration curve indicates that wet vegetation weights are highly correlated with herbage meter readings in the study area ( $r^2 = 0.95$ ). The effect of the exclosure on vegetation production is significant; existing production in the ungrazed site 2 was 5395 lb/acre, while in the grazed site 1 it was 1560 lb/acre (Table 4).

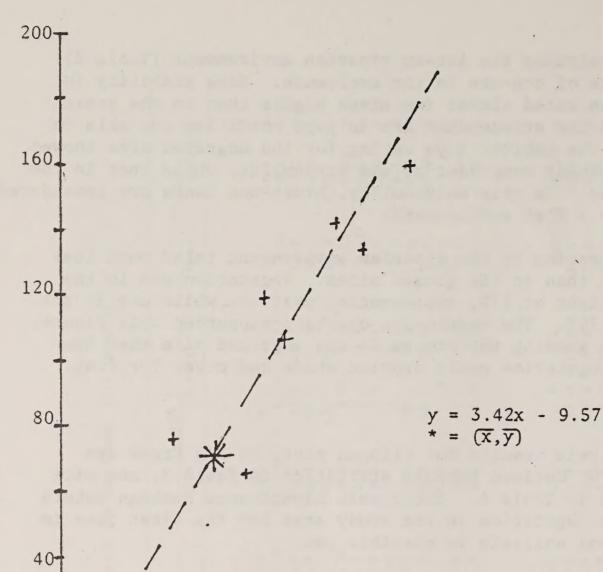
# Electrofishing

Table 5 lists the results of fish sampling in Big Creek in 1979. There is very little variability in numbers or size of game fish sampled in the study area. Only eighteen rainbow trout were collected (0.0008/ft<sup>2</sup>), with an average length of 9.6 in. (242.5 mm) and weight of 5.0 oz. (142.8 gm). The large size of these fish indicates they are apparently planted fish rather than a native spawning population. Three cutthroat trout were collected in site 3 in a pool just above the exclosure fence.

The fish population in the study area appears to be composed chiefly of non-game species. Seven hundred forty four sculpin  $(0.09/ft^2)$  were collected in site 1, 788  $(0.10/ft^2)$  in site 3, and fewer  $(383 \text{ or } 0.05/ft^2)$  in the ungrazed site 2. Sucker were also sampled, with a total of 71  $(0.003/ft^2)$  collected in the study area.

#### Hydraulic Geometry

Stream channel cross section profiles for selected transects on Big Creek are shown in Figure 5 for site 1, Figure 6 for site 2, and Figure 7 for site 3. The cross sections show a general tendency for a deeper, more defined stream channel in the ungrazed section (site 2) than in either of the grazed sites (site 1 or 3). This difference may become more obvious in the future as grazing continues. Table 6 lists the stream velocities for selected transects on Big Creek.



20

Wet

Weight (gm)

Meter Reading

Figure 4. Regression of vegetation weight to meter readings for

60

80

100

40

Big Creek (10/14/79).

Table 3. Herbage analysis calibration data. Equation fits the formula y = a + bx.

				Variable			
Year	x	ÿ	a	ъ	Avg. Prod. (1b/acre)	r	r <sup>2</sup>
1979	23.2	69.8	-9.57	3.42	3350	0.97	0.95

Table 4. 1979 herbage analysis means by study site.

	Variable					
Study Site	Meter Reading	Weight	Production (lb/acre)			
Site 1 (grazed)	13.3	32.5	1560			
Site 2 (ungrazed)	34.6	112.4	5395			

Fish collection data for Big Creek, Utah in 1979 (collected 8/7/79). 5. Table

1	La series a second			
No./m <sup>2</sup>	0.007 0.009 0.010 0.009	0 0 0.004 0.001	1.07 0.87 1.09 0.93	0.023 0.050 0.030 0.030
No./ft	0.0007 0.0009 0.0009 0.0008	0 0 0.0004 0.0001	0.09 0.05 0.10 0.09	0.002 0.005 0.003 0.003
95% <u>1</u> /	N N N N N N N N N N N N N N N N N N N	N. A.	867-1025 383- 387 933-1113 2130-2270	16- 21 34- 35 21- 23 71- 75
Pop. Est.	N.A. N.A. N.A.	N.A. N.A. N.A.	946 384 1023 2200	17 34 21 72
e. Weight (gm)	129.9 137.5 156.7 142.8	0 0 40.2 40.2	5.8 5.3 5.6	23.9 54.5 9.1 40.1
Ave. W	4.6 4.8 5.5 5.0	0 0 1.4	0.20 0.22 0.19 0.20	0.84 1.93 0.32 1.40
Length (mm)	231.4 238.0 254.4 242.5	0 0 133.0 133.0	HHHH	H H H H H H H H H H H H H H H H H H H
Ave. Lo	9.1 9.4 10.0 9.6	0 0 5.2 5.2	N.T. N.T. N.T. N.T.	T. N. N. T.
Total No. Collected	5 6 7 18	00 m m	744 383 788 1915	16 34 21 71
	Rainbow Trout Site 1 Site 2 Site 3 Overall	Cutthroat Trout Site 1 Site 2 Site 3 Overall	Sculpin Site 1 Site 2 Site 3 Overall	Sucker Site 1 Site 2 Site 3 Overall

 $\frac{1}{2}$ /C.I. - confidence interval  $\frac{2}{N}$ /N.A. - not available  $\frac{3}{N}$ /N.T. - not taken

Table 6. Stream velocities at cross section transects, Big Creek, Utah (10/16/79).

Transect	Mean Velocity	Transect	Mean Velocity	Transect	Mean Velocity
		220110000	7010010)	220000	
27	1.89	87	0.96	149	0.72
28	1.43	88	1.00	150	0.45
29	1.24	89	0.91	151	0.91
30	0.90	90	0.81	152	0.68
31	1.29	91	1.39	153	1.94
32	1.56	92	0.90	154	1.06
33	0.98	93	0.48	155	1.08
34	1.03	94	0.61	156	1.13
35	0.56	95	0.66	157	0.44
36	1.66	96	0.31	158	0.42

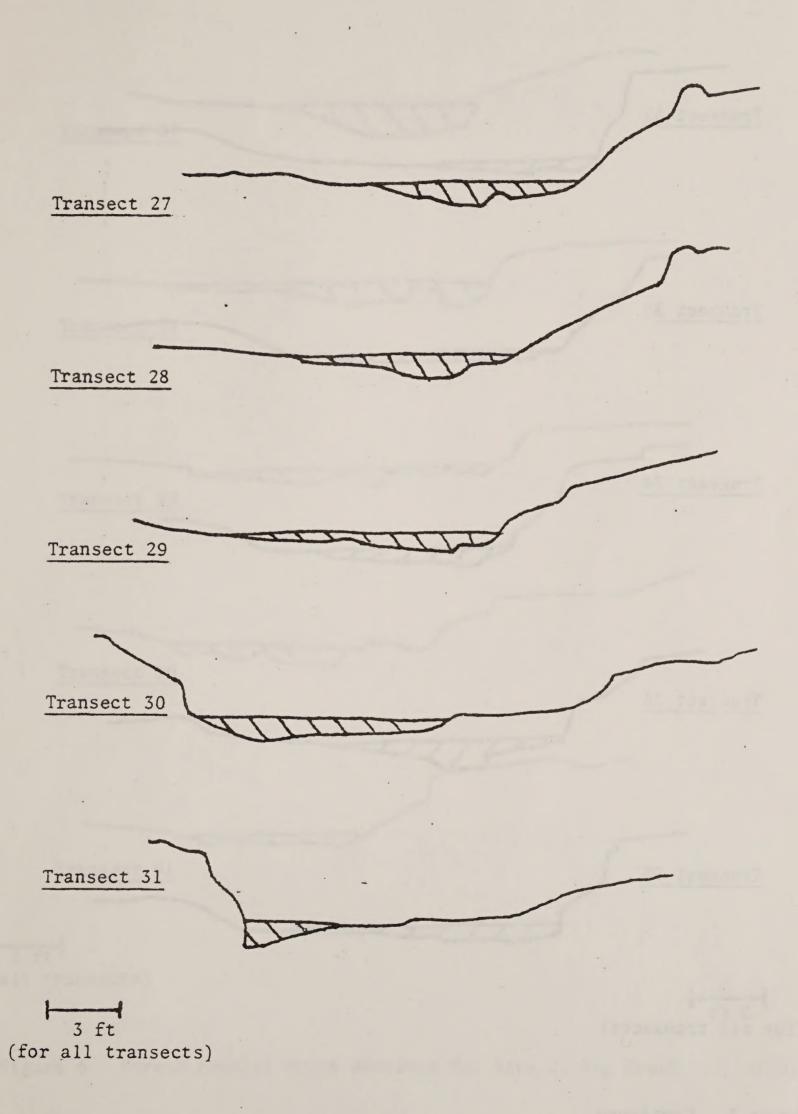


Figure 5. Stream channel cross sections for Site 1, Big Creek (10/16/79).

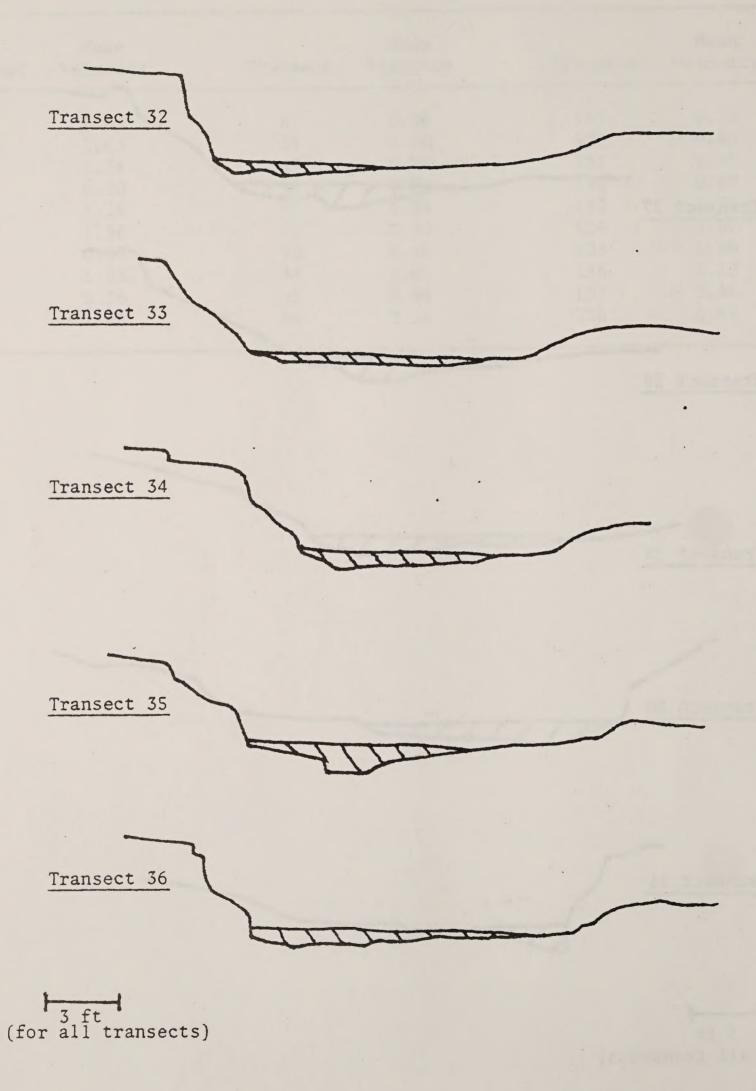
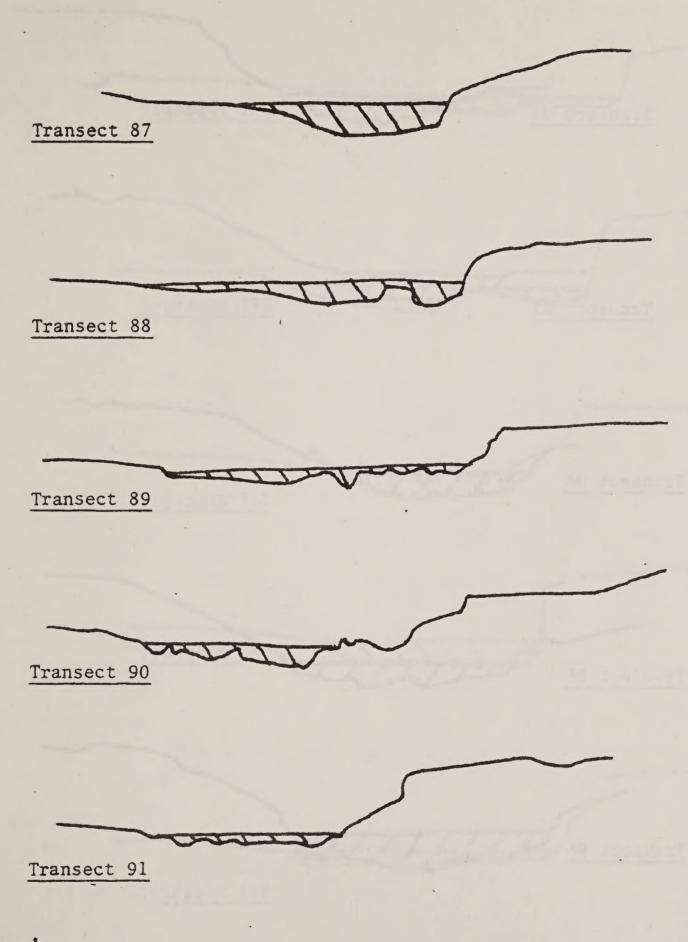
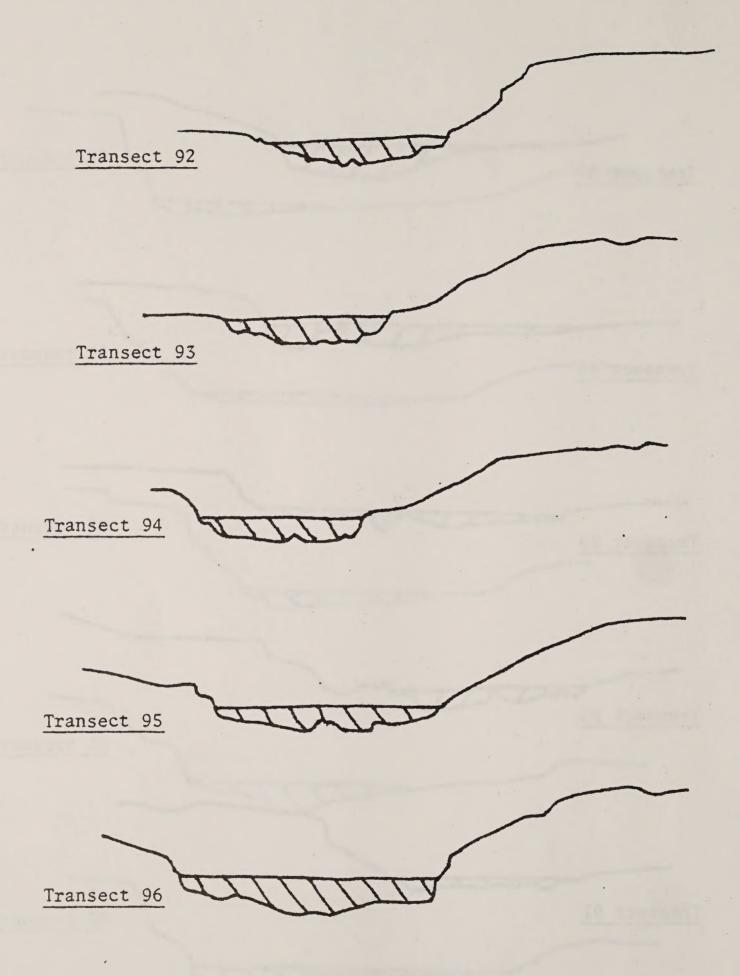


Figure 5. Continued.



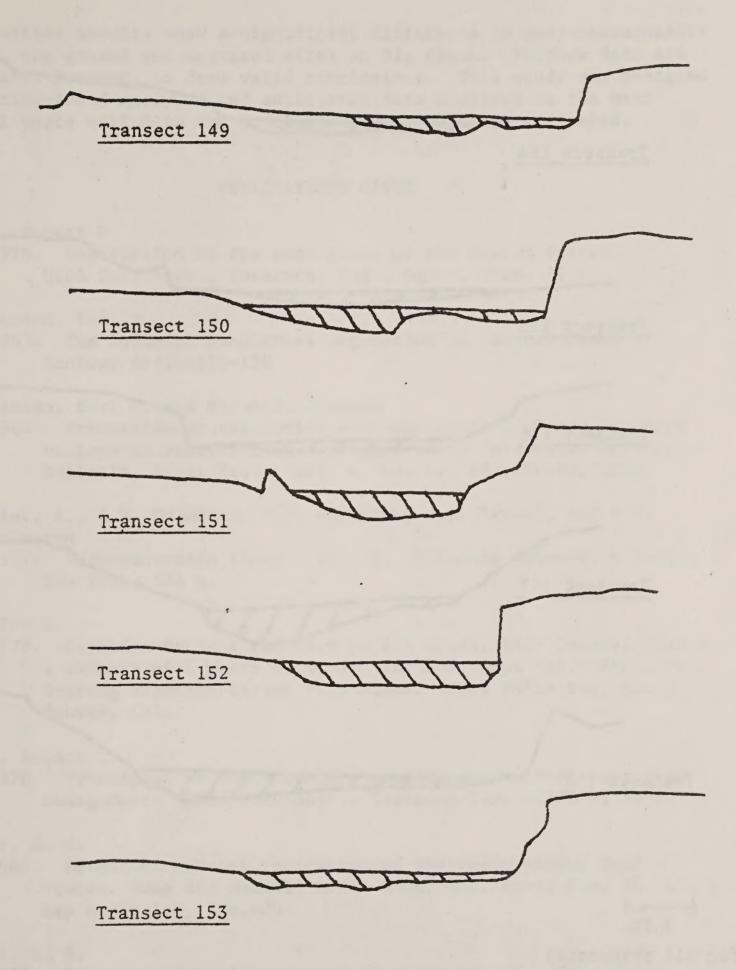
3 ft (for all transects)

Figure 6. Stream channel cross sections for Site 2, Big Creek (10/16/79).



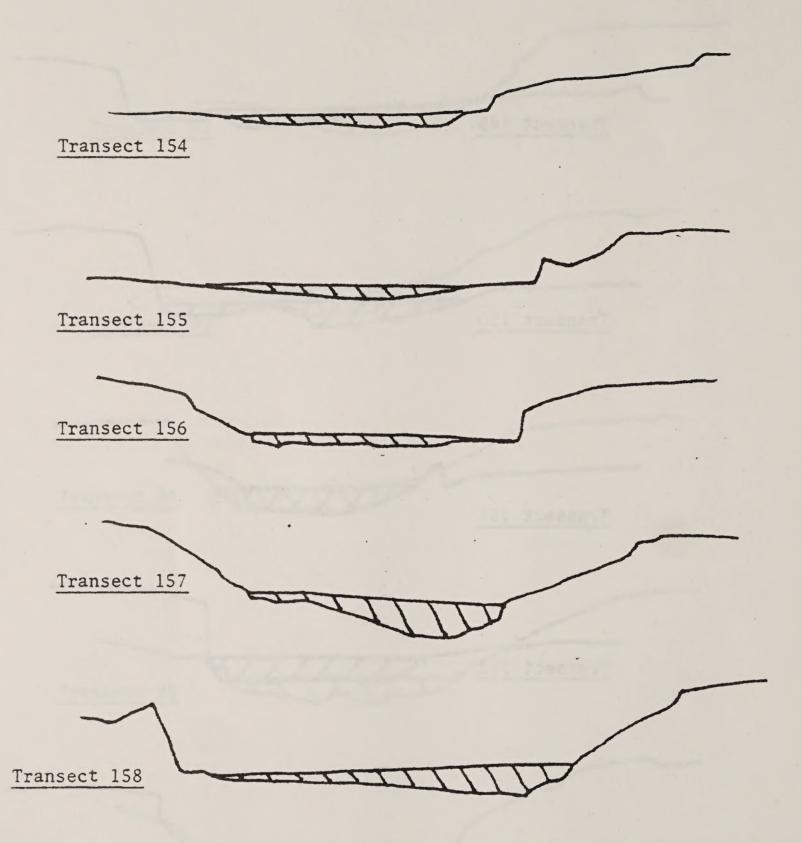
3 ft (for all transects)

Figure 6. Continued.



3 ft (for all transects)

Figure 7. Stream channel cross sections for Site 3, Big Creek (10/16/79).



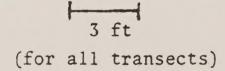


Figure 7. Continued.

#### DISCUSSION

Initial results show a significant difference in many measurements between the grazed and ungrazed sites on Big Creek. Further data are necessary, however, to draw valid conclusions. This study was designed for a time-trend analysis and additional data acquired in the next several years will make the conclusions more definite and valid.

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